

Lecture Module - Electrical Signals

ME3023 - Measurements in Mechanical Systems

Mechanical Engineering

Tennessee Technological University

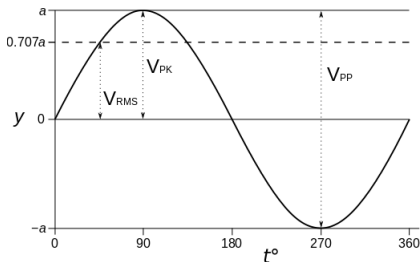
Topic 1 - Classification of Signals

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- Introduction to Signal Concepts
- Analog, Discrete, or Digital
- Static or Dynamic
- Deterministic or Non-Deterministic

Introduction to Signal Concepts

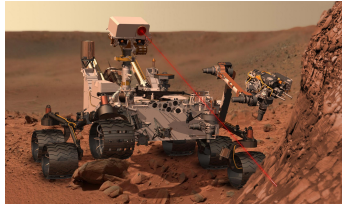
Signal, Amplitude, and Frequency



The shape and form of a *signal* are often referred to as its *waveform*. The *waveform* contains information about the magnitude and *amplitude*, which indicate the size of the input quantity, and the *frequency*, which indicates the way the *signal* changes in time.

Introduction to Signal Concepts

A *signal* is the physical information about a measured variable being transmitted between a process and the measurement system, between the stages of a measurement system, or as the output from a measurement system.



Analog, Discrete, or Digital

- **Analog Signal-** magnitude is continuous in time
- **Discrete Time Signal-** magnitude at points in time
 - sampling at repeated time intervals
- **Digital Signal-** exists in discrete points in time
 - magnitude is also discrete

Analog, Discrete, or Digital

Analog describes a signal that is continuous in time. Because physical variables tend to be continuous, an analog signal provides a ready representation of their time-dependent behavior.

Examples: voltage in a circuit

Analog, Discrete, or Digital

*...a **discrete time** signal, for which information about the magnitude of the signal is available only at discrete points in time. A discrete time signal usually results from the sampling of a continuous variable at repeated finite time intervals.*

Examples:

Analog, Discrete, or Digital

A *digital* signal has two important characteristics. First, a digital signal exists at discrete values in time, like a discrete time signal. Second, the magnitude of a digital signal is discrete, determined by a process known as *quantization* at each discrete point in time.

Examples:

Static or Dynamic

Signals may be characterized as either static or dynamic. A static signal does not vary with time.

A dynamic signal is defined as a time-dependent signal. In general, dynamic signal waveforms, $y(t)$, may be classified as shown in Table 2.1.

Deterministic or Non-Deterministic

A deterministic signal varies in time in a predictable manner, such as a sine wave, a step function, or a ramp function, as shown in Figure 2.5. A signal is steady periodic if the variation of the magnitude of the signal repeats at regular intervals in time.

Also described in Figure 2.5 is a non-deterministic signal that has no discernible pattern of repetition. A non-deterministic signal cannot be prescribed before it occurs, although certain characteristics of the signal may be known in advance.

Deterministic or Non-Deterministic

Table 2.1 Classification of Waveforms

I. Static	$y(t) = A_0$
II. Dynamic	
Periodic waveforms	
Simple periodic waveform	$y(t) = A_0 + C \sin(\omega t + \phi)$
Complex periodic waveform	$y(t) = A_0 + \sum_{n=1}^{\infty} C_n \sin(n\omega t + \phi_n)$
Aperiodic waveforms	
Step ^a	$y(t) = A_0 U(t)$ $= A_0 \text{ for } t > 0$
Ramp	$y(t) = A_0 t \text{ for } 0 < t < t_f$
Pulse ^b	$y(t) = A_0 U(t) - A_0 U(t - t_1)$
III. Nondeterministic waveform	$y(t) \approx A_0 + \sum_{n=1}^{\infty} C_n \sin(n\omega t + \phi_n)$

^a $U(t)$ represents the unit step function, which is zero for $t < 0$ and 1 for $t \geq 0$.

^b t_1 represents the pulse width.